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Plan for integrating conservation with chemistry in Montana high schools

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A PLAN FOR INTEGRATING CONSERVATION WITH CHEMISTRY IN MONTANA HIGH SCHOOLS

by

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CHAPTER I

SCOPE OF THE CONSERVATION PROBLEM IN MONTANA

> I give my pledge as an American to save and faithfully to defend from waste the natural resources of my country--its soil and minerals, its forests, waters and wildlife.
>
> Conservation Pledge

Conservation of natural resources is not a new idea. Most of Montana's citizens can hardly remember a time when there were no restrictions on the use of our timber resources or when hunting and fishing were unregulated. The Soil Conservation Service, the Water Resources Board, the Fish and Game Commission, and many other agencies of the government pertaining to conservation have been in existence for many years.

But what of conservation education? Not until 1946 was any real action taken to present conservation to Montana's school children. In that year a committee representing six units of the University of Montana, at the request of Miss Elizabeth Ireland (then State Superintendent of Public Instruction), drew up a course outline to be presented to Montana's teacher-training institutions:[1]

> The course is designed largely for teachers in the elementary and secondary schools of Montana. An increasing awareness of the need for the conservation of both natural and human resources is evident over the nation, and the importance of the educational system in providing the informational background for this movement

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[1] J. W. Severy, "Conservation of Natural and Human Resources in Montana," Montana Education, 26:17 (Helena, Montana) April, 1950.

> can hardly be overemphasized. The aim is to give the Montana teacher an overview of the major fields and problems in the conservation movement which can be used in many related fields in the classroom in all grades.[2]

Since the implementation of this teacher-training course, much has been done on the part of our teacher-training institutions and the State Department of Public Instruction to promote conservation teaching. One of the more successful programs developed, in addition to regular conservation courses at all Montana teacher-training institutions, is the conservation workshop conducted by Montana State University, Northern Montana College, Eastern Montana College of Education, and in past years by Montana State College.

The workshop idea received its greatest impetus from the Conservation Education Conference held August 11 and 12, 1949, at Montana State University. This conference was sponsored jointly by the Montana Conservation Council and Montana State University. It resulted in the offering of the conservation workshop the following summer and subsequent summers at Montana State University.[3] The soil conservation districts of the state have cooperated in making it possible for teachers to participate in these workshops by providing scholarships to help pay the cost of the course.

From the foregoing information it would seem that a good program of conservation teaching throughout the state

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[2]Montana, Greater University of, Conservation of Natural and Human Resources in Montana, (Mimeographed, Helena, Montana, 1946), Foreword.

[3]Rose Williams, "History of the Montana Conservation Workshops," Report of the 1951 Conservation Workshop, (Montana State University, Missoula, August, 1951), p.4.

would be assured. However, Truman C. Anderson, in an article appearing in the April, 1950, issue of Montana Education, listed these obstacles to effective teaching of conservation still to be overcome:

> 1. Inertia or lack of appreciation by the public of our conservation problems.
> 2. Lack of agreement by educational leaders on policies and methods of teaching conservation.
> 3. Inadequate facilities (including teacher training) for effective teaching of conservation.[4]

Some of the obstacles listed by Mr. Anderson have been overcome since the article was published. The Montana Conservation Council has taken active leadership in this respect, and it was largely through their efforts that the following law was enacted by the 1951 Montana legislature:[5]

> On and after September, 1951, a continuing program of conservation education shall be taught in the public elementary and secondary schools of the state. The extent of such a program, and its application, shall be determined by the state board of education in cooperation with the state superintendent of public instruction, and shall include a widespread understanding of conservation as to facts, principles, and attitudes.
>
> To supplement this broad conservation program in the elementary and secondary schools of the state, the separate units of the greater university of Montana shall make available to all students in teacher preparatory courses basic instruction in conservation education; and the Montana state college at Bozeman and the Montana state university at Missoula shall include instruction in conservation in their community or public service programs.
>
> The state board of education shall determine the type of conservation education to be taught in the public schools of the state and shall also determine the type of service in this general conservation program to be

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[4]Truman C. Anderson, "Legacy of Acres," Montana Education, 26:15 (Helena, Montana), April, 1950.

[5]Williams, op. cit., p. 6.

> given by the above named agencies at the various units at the greater university of Montana; provided that conservation education shall not be taught as a specific subject in the elementary and secondary schools but rather shall be taught as a part of and integrated with all other related subjects and courses.[6]

This law provides the basis for an adequate conservation education program in Montana. Not that the law itself will improve instruction, but can be the focal point for further study and action. The law should have the effect, on educators at all levels, of stimulating an increased interest in conservation and should help to make conservation education more uniform and consistent. The question still remains, however, as to how effective a program of conservation education is being carried out in the public secondary schools of Montana.

Two examples of specific work in the field of integration of conservation with school subjects are worth noting. One is the school forest project being carried out at Plains, Montana, under the direction of Mr. Emerson Richardson, a Plains teacher. Here all children in the Plains Schools are given the opportunity to practice conservation on their own plot of forty-seven acres of cut-over land deeded to the school by the Anaconda Copper Mining Company. Their activities consist of thinning and pruning, planting new trees, experimenting with range grasses, and using tools, and experience

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[6] Montana Session Laws, 1951, (Helena, Montana: State Publishing Company), Chapter 125, pp. 211-212.

in wood utilization.[7]

Another example is the handbook prepared by the seminar class in conservation education during the workshop of 1952 entitled "Suggested Correlation of Junior High School Subjects to Insure the Teaching of Wise Use of our Natural Resources". The above handbook contains an outline of the basic concepts of conservation, suggested activities, projects and field trips. It also includes a teacher's bibliography of basic conservation references, an index of teaching aids, and a list of free materials.[8]

Although both of the above examples indicate progress toward an effective planned program of conservation education, such a quality of teaching must be considered the exception rather than the rule. However, it is not within the scope of this paper to attempt to measure either the quantity or quality of the conservation teaching being done in Montana. A study of this nature was made during the school year 1949-1950 by Mr. David Thorn of Shelby Schools, Shelby, Montana. Among other things, Mr. Thorn wanted to learn the amount of conservation being taught and the methods used in Montana secondary schools. He received responses from 801 teachers

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[7] Emerson Richardson, "The Plains School Forest," Report of the 1952 Conservation Workshop, (Montana State University, 1952).

[8] Emerson Richardson and Helen Duden, Suggested Correlation of Junior High School Subjects to Insure the Teaching of Wise Use of our Natural Resources, (Mimeographed report of the 1952 Conservation Workshop Seminar, Missoula, August, 1952) pp. 20-21.

representing 137 schools. The majority of the teachers who indicated they were teaching conservation stated that they did so incidentally. Only a minority said that they integrated conservation as a planned part of their courses.[9]

The problem facing teachers then, is how to implement an effective program of planned conservation education rather than to allow "incidental teaching" of conservation to continue. If conservation is as important as we believe, then we cannot allow its teaching to be left to chance or the haphazard methods of "incidental" treatment. Mr. Charles Mattill of the Helena Schools, Helena, Montana, touched on this problem in the discussion of a unit in conservation to be integrated with social studies. Mr. Mattill writes, "At the present time there is no adopted course of study and presentation of this subject, but its manifestations are nevertheless so much in evidence that it should have more than incidental treatment."[10]

The alternative to incidental teaching (in view of the legislative act which stipulates that conservation not be taught as a separate subject) is a planned program of integration of conservation into each high school course which lends itself easily to such integration. The purpose of this

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[9]David Thorn, "What is Being Done About Conservation Teaching?" Montana Education, 24:10 (Helena, Montana) April, 1950.

[10]Charles Mattill, "More Than Incidental Teaching," Montana Education, 26:20 (Helena, Montana) April, 1950.

paper is to make such a plan for the integration of conservation with a course in high school chemistry. Teachers in other fields may be able to make use of this plan as a guide to making their own plans and adapting them to their local situations.

Nothing could be found in the literature which would indicate that a plan such as the one proposed has been previously published. Many articles were found which deplored the lack of such specific plans, indicating that an effort of this sort should be the next step toward efficient and consistent conservation teaching in our secondary schools. The plan outlined here is unique also from the standpoint that it identifies conservation with the resource problems of Montana. Local situations cannot be stressed too much in the teaching of conservation.

CHAPTER II

MONTANA CONSERVATION: AN OUTLINE AND RESOURCE GUIDE

The outline of conservation material presented in this chapter provides a guide to the integration of conservation into all courses in high school. Not all the phases of conservation may be included with one subject. For example, the history of the conservation movement and sociological problems arising from resource depletion fit most naturally into the social studies, while wildlife conservation, the plant succession theory, and the relationship between climate, plants, and animals belong in biology and general science.

Only the main principles and subheadings of a course in conservation have been outlined here. Source materials for this outline stem from the writer's personal experience in teaching conservation, personal interviews with Mr. Gebhart, director of the summer workship in conservation, and Conservation of Natural and Human Resources in Montana, a course outline for teacher preparation.[1]

PART I: OUTLINE OF CONSERVATION PRINCIPLES

I. Orientation
   A. Definition: Conservation means the wise use of natural resources

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[1] Montana, Greater University of, Conservation of Natural and Human Resources in Montana, (Mimeographed, Helena, Montana, 1947.

B. Types of resources
   1. Renewable
   2. Non-renewable
C. Kinds of resources
   1. Soils
   2. Water
   3. Minerals
   4. Forests and grasslands
   5. Wildlife
D. History of the conservation movement
   1. Men who stopped gullies
      a. Patrick Henry
      b. George P. Marsh
      c. Franklin Hough
      d. Gifford Pinchot
      e. Theodore Roosevelt
      f. Franklin D. Roosevelt
   2. Political and economic factors contributing to our present status
      a. "frontier philosophy"
      b. world conflicts

II. Soils, climate, and vegetation
A. Vegetation types
   1. Tropical rain forest
   2. Temperate hardwood forest
   3. Coniferous forest
   4. Grassland
   5. Desert
B. Relationship of soil fertility to vegetation types
C. Soils
   1. Definition of soil
   2. Significance of soils
   3. Formation of soils
      a. parent rock
      b. physical weathering
      c. chemical weathering
      d. biological processes
      e. rate of formation
      f. soil transport and accumulation
   4. Soil types
      a. pedocals
      b. pedalfers
D. Climate
   1. Rainfall zones
   2. Temperature zones
E. Plant succession theory
F. Interrelationship of soil, climate and vegetation

III. Forest conservation
A. Forest ownership
   1. Goverment reserves
   2. Ownership by major industries
   3. Small private ownership

B. Types of logging operations
   1. Clear cutting
   2. Selective logging
   3. Block system
C. Forest enemies
   1. Fire
   2. Insects
   3. Parasites
D. Forest resources of Montana
   1. Ponderosa pine
   2. Douglas fir
   3. Other species
E. Wood utilization
   1. Products of thinning
   2. Use of slash
   3. Sawdust products and uses
   4. Forest products research
   5. Effect upon local and state economy by encouraging local wood-products industries

IV. Soil conservation
A. Controlling erosion
   1. By maintaining cover and organic content
   2. By regulating grazing
   3. By crop rotation and good tillage practices
   4. By proper irrigation methods
B. Maintenance of fertility
   1. Replacing humus
   2. Minimizing leaching of minerals
   3. Chemical fertilizers

V. Water resources
A. Source problem
   1. Flood control
      a. small dams
      b. watershed control
   2. Relationship of water to soil, vegetation, and wildlife
   3. Maintenance of ground water supply
B. Pollution problem
   1. Industrial pollution
   2. Municipal pollution

VI. Wildlife conservation
A. Present resources
   1. Fish
   2. Birds
   3. Mammals
B. Factors controlling supply
   1. Available food
   2. Population
   3. Predators

C. Conservation practices
   1. Regulation of bag limits
   2. Restocking
   3. Provision for feeding of game

VII. Mineral resources
   A. Organic mineral resources in Montana
      1. Petroleum
      2. Coal
   B. Inorganic mineral resources in Montana
      1. Copper
      2. Others
   C. Practices in maintaining supply of minerals
      1. Stockpiling
      2. Rationing
      3. Obtaining friendly sources of supply abroad
      4. Synthetics
      5. Extraction from low-grade sources

PART II: A GUIDE TO MONTANA'S RESOURCES

As a further aid to teachers in integrating conservation into their high school subjects, maps showing the distribution of Montana's forest and mineral resources were obtained or prepared. All learning becomes more effective when related to a local situation. Conservation, especially, is made meaningful when local resources are identified on a map and studied in relation to the home community.

The forest resource map (see Map No. 1, p. 13) was originally prepared as a part of a booklet entitled Forest Resources of Montana,[2] published by United States Department of Agriculture. Additional copies of this map were obtained through the courtesy of the Northern Rocky Mountain Forest and Range Experimental Station, Information and Education

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[2] S. F. Hutchinson and F. D. Kemp, Forest Resources of Montana, United States Department of Agriculture Forest Resource Report No. 5, United States Government Printing Office, Washington, D. C., 1952.

division," Federal Building, Missoula, Montana. The maps showing the areal distribution of Montana's mineral wealth (pp. 14, 15, 16, and 17) were reproduced from a resource map contained in a booklet entitled The Mineral Resources of Montana,[3] published by Montana State Chamber of Commerce.

While the development of the metals resources of Montana has remained fairly static since 1936 (the date of publication of the latest mineral resources map) petroleum resource development has been greatly expanded. For this reason the petroleum resources distribution as shown by the map is out of date. For the purpose of study of this subject, the eastern one-third of Montana may be considered as being a potential oil-producing area.[4]

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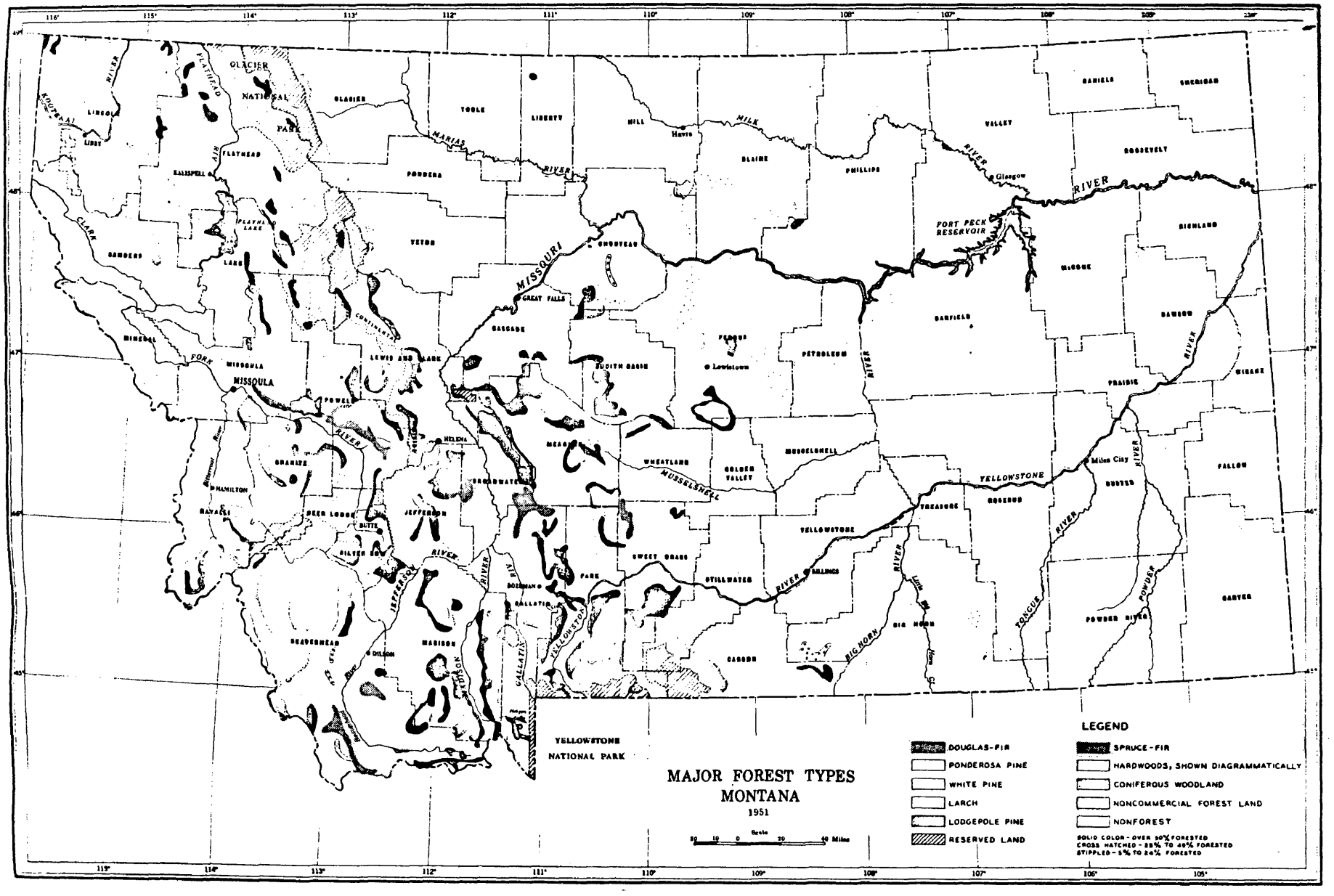
[3]Montana Mining Association, The Mineral Resources of Montana, Montanans, Incorporated, (State Chamber of Commerce,) Helena, Montana, 1936. pp. 4-5.

[4]Kenneth P. McLaughlin, Chairman, Department of Geology, Montana State University, Personal interview, June 24, 1953.



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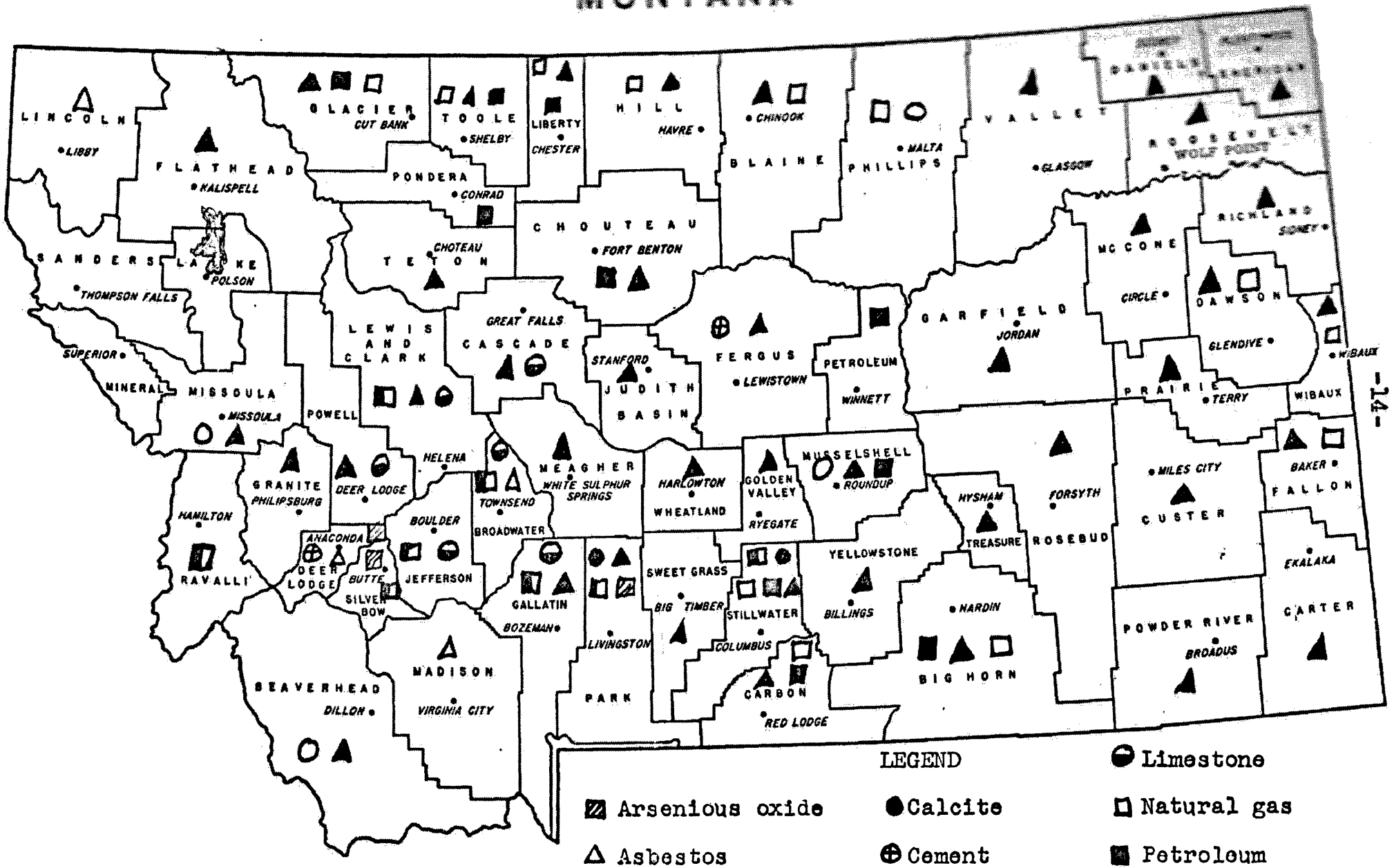
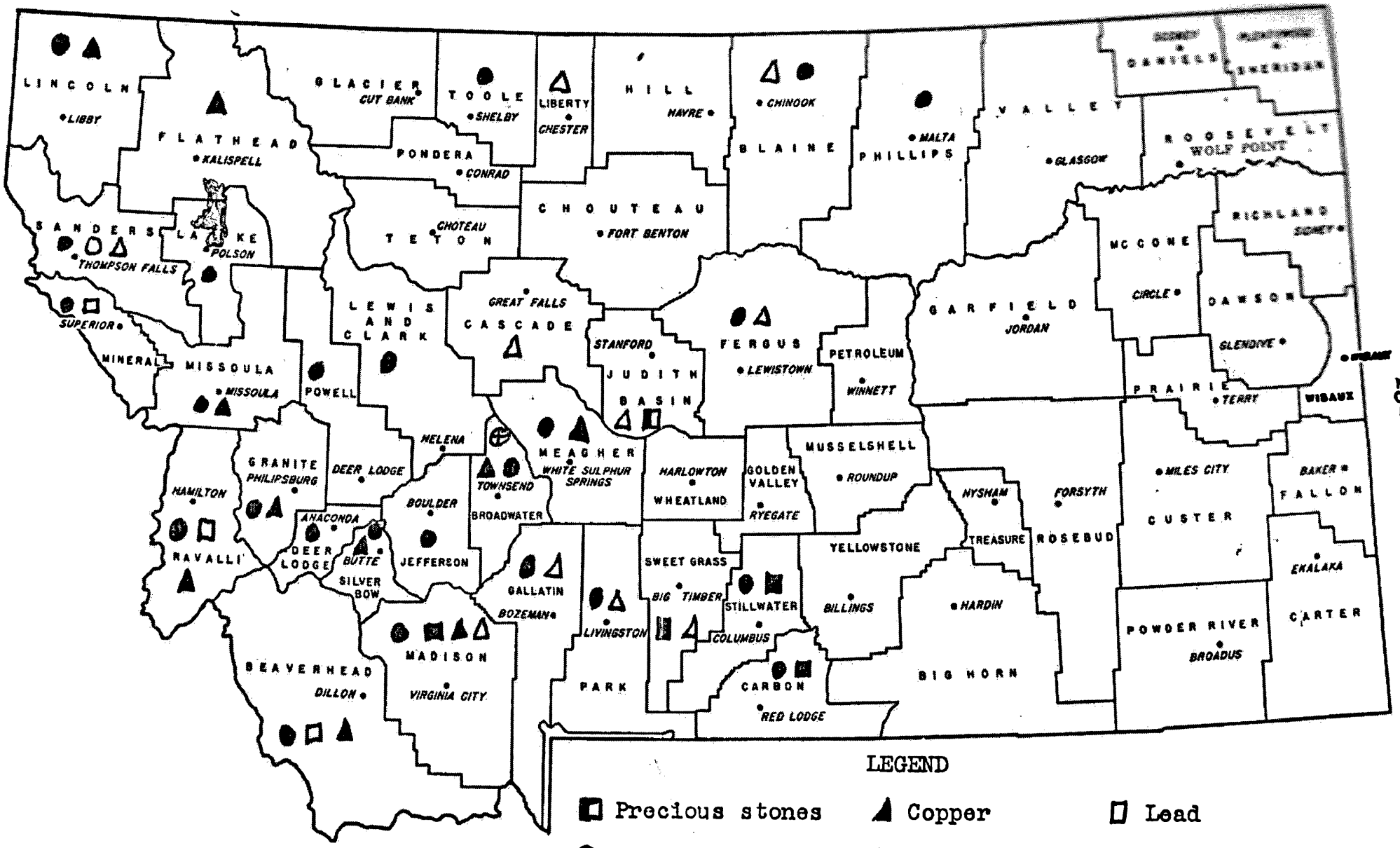


Map No. 2, Mineral Resources of Montana

MONTANA

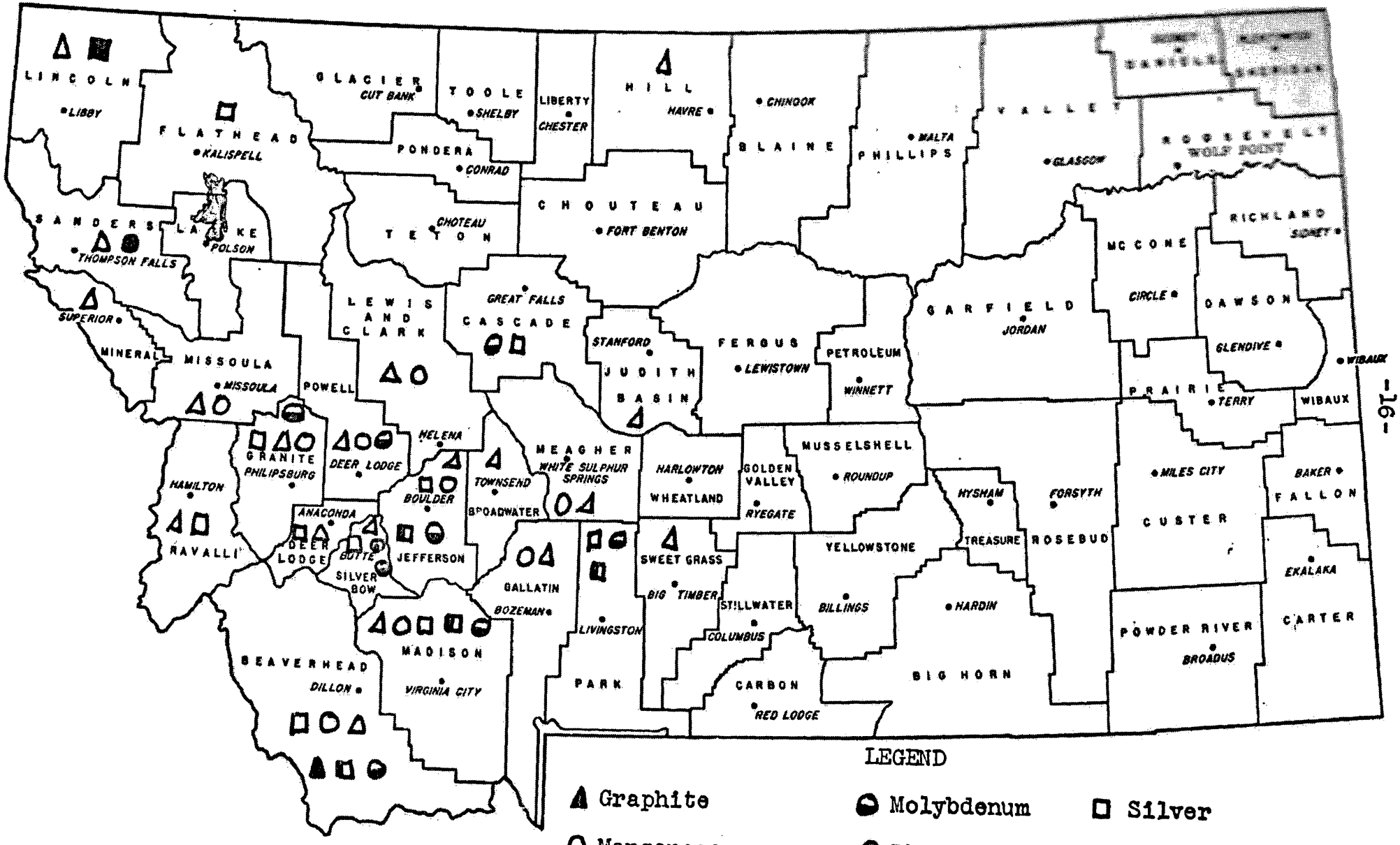


LEGEND

Precious stones	Copper	Lead
Antimony	Gold	Zinc
Chromium	Iron	

Map No. 3, Mineral Resources of Montana

MONTANA

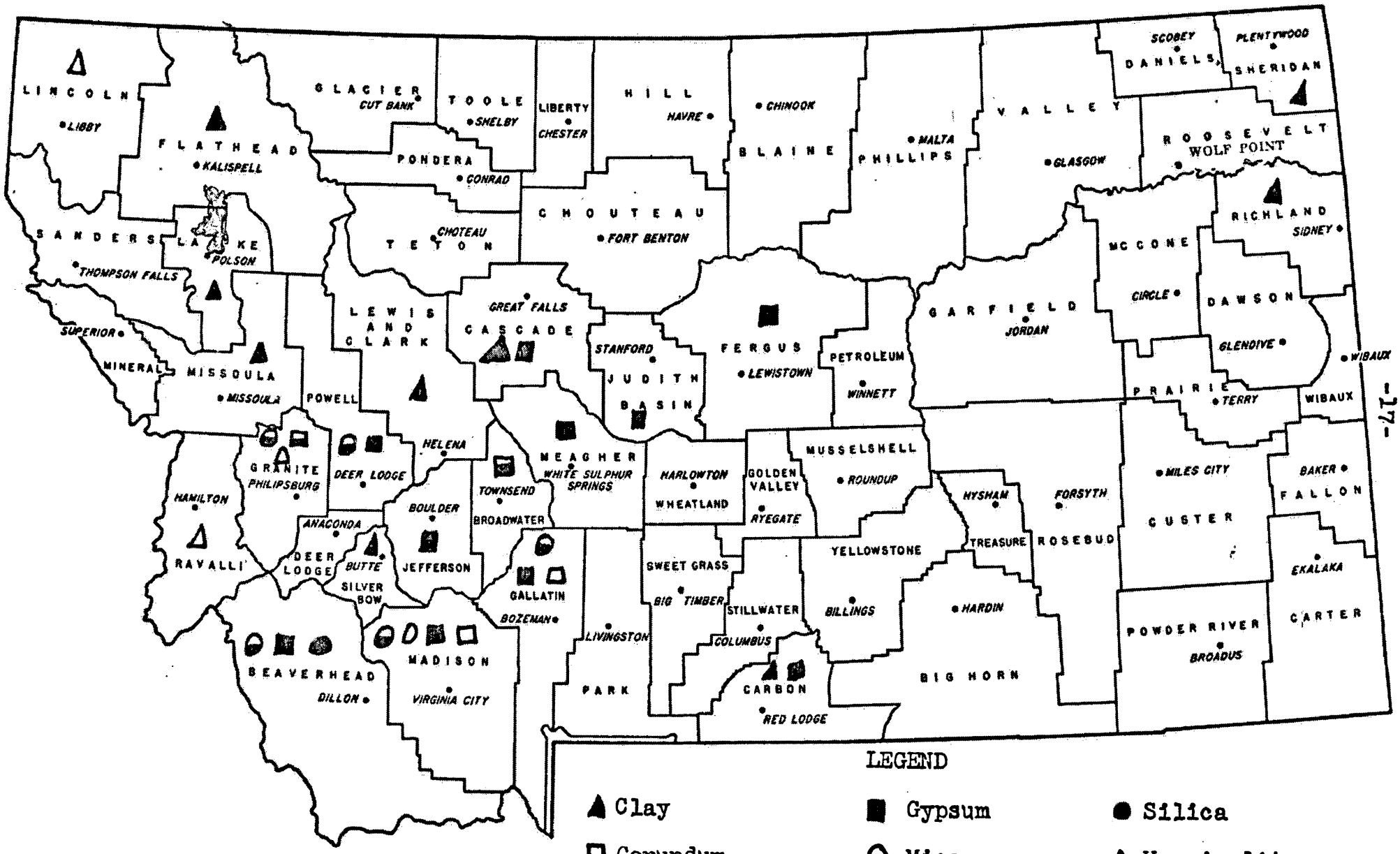


LEGEND

- Graphite
- Manganese
- Predominant metal uncertain
- Molybdenum
- Platinum
- Silver
- Tungsten
- Vanadium

Map No. 4, Mineral Resources of Montana

MONTANA



LEGEND

- Clay
- Gypsum
- Silica
- Corundum
- Mica
- Vermiculite
- Diatomite
- Phosphate rock

Map No. 5, Mineral Resources of Montana

CHAPTER III

CHEMISTRY AND CONSERVATION

Textbooks and reference materials on conservation have appeared in increasing numbers since 1910. Almost without exception, however, these books are concerned with the technical subject matter of conservation. What are needed now are more references regarding the educational philosophy and teaching problems of conservation.[1] Specific plans showing how conservation can be woven into the subject matter of each course in high school will enable Montana teachers to teach conservation more effectively and uniformly.

Such a plan for the specific integration of conservation with chemistry is the purpose of this project. The plan is in outline form and is organized under the headings of forests, soils, water, wildlife, and minerals.[2] Obviously, all aspects of conservation cannot be made to fit into a chemistry course. Some aspects should be left to the subject matter fields of biology and the social studies. The aim has been to include only those elements of conservation which fit in naturally in a high school chemistry course.

No attempt has been made to cut down the amount of material so it could all be reasonably included during a

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[1]George T. Renner, Conservation of Natural Resources, (New York. John Wiley and Sons, Incorporated, 1942), p. vii.

[2]See Appendix A.

year's course in chemistry. If the teacher is determined to include conservation with the course of study in chemistry, he will be able to select from the outline those elements of conservation which suit his aims and objectives.

Two approaches to the method of presentation of the plan for integration were recognized. One method was to determine which units in a chemistry course were best suited to the integration of conservation with the course material, then to indicate the particular aspects of conservation to be included with each unit. The other method, the one adopted, was to organize the conservation material to be integrated with chemistry into the logical divisions of soils, water, forest, wildlife, and mineral conservation. By this method, the teacher is enabled to use his own discretion in picking out the material he can use. The reasoning was that it would be a presumption on the author's part to determine the exact amount of conservation to be presented and to specify which aspect of conservation should be taught with each unit of chemistry. Furthermore, the organization and content of chemistry courses differ from school to school so that the sequence of presentation must be left up to the individual teacher.

Before a plan such as the one proposed is implemented, a survey of local resources should be made. Interest in conservation principles can be stimulated greatly by relating these principles to local problems. A survey of local resources will also suggest to the teacher many devices for making the conservation phase of chemistry more appealing.

field trips, lectures by local or regional conservation personnel, and projects by the students are some of the familiar devices employed by most science teachers.

Free materials in the form of bulletins, pamphlets, movies, film strips, and slides are also available. A selected list pertaining to conservation in chemistry is included in Appendix B.

Also included in Appendix B is a short list of basic references in the field of conservation. A textbook for each student is not necessary, but every high school should have at least one reference in each of the areas of soil, forests, water, minerals, and wildlife conservation.

Education is the only alternative to enforced conservation by legislation. Teachers can help future generations come to terms with nature. America cannot have a future as a free nation without education toward wise use of her natural resources.

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A P P E N D I X

APPENDIX A

A PLAN FOR INTEGRATING CONSERVATION WITH CHEMISTRY

IN MONTANA HIGH SCHOOLS

I. Chemistry and Forest Conservation

A. Chemistry of plant growth
   1. Photosynthesis is a chemical process involving carbon dioxide and water.
      a. Animals are a link in the carbon dioxide-oxygen cycle.
      b. Sugar and starch are the end-products of photosynthesis.
      c. Energy source for photosynthesis is the sun.
      d. Our present heat and power is provided by sunlight of past ages.
      e. Photosynthesis depends upon certain soil minerals.
   2. Chemical composition of plants
      a. Sources of elements in plants are air, soil, and water.
      b. Different plants have different chemical composition.
      c. Nutritional deficiencies in animals are caused by lack of certain elements in soils and plants.
   3. Leaves change their color as a result of chemical change.
   4. Osmosis is a chemical phenomenon
      a. Osmosis is dependent upon mineral concentration in soil water.

B. Forest utilization
   1. Pulp wood is an important Montana forest product.
      a. Conifers provide 85 to 90 per cent of pulp.
      b. Pulping processes are sulfate, sulfite, and soda.
   2. Rayon is made from wood.
      a. Main sources of rayon are wood and cotton.
      b. Rayon is made by the viscose and acetate process.
   3. Plastics are chemical products of organic origin.
   4. Many products are made from wood sap.
      a. Turpentine is extracted from pine resins.
      b. Rosin is a by-product of turpentine manufacture.
      c. Maple sugar is of importance in New England and Ohio.
   5. Tree bark provides useful chemicals.
      a. Tannins are used in curing leather.
      b. Dyestuffs are still being made from bark.
      c. Many crude drugs have bark as their origin.

6. Forests are important from conservation standpoint.
   a. Trees produce cellulose faster than any other plant.

C. Forest Conservation
   1. Trees hold soil and help rebuild worn-out soil.
   2. Trees assist in maintaining constant flow of water for power and irrigation use.
   3. Chemistry points the way toward more efficient and complete forest product utilization.
      a. Conversion of slash, thinned trees, sawdust into marketable products.
      b. Chemical transformation of lignins.
      c. Conversion of sawdust into sugar.
   4. Forest and grass fires affect soil fertility and cause chemical imbalance of large areas.

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II. Chemistry and Soil Conservation

A. Soil formation and structure

1. Soil framework is composed of aluminum silicates.
2. Several forces operate to form soil from parent rock material.
   a. Physical weathering accomplished by frost, wind, and waves.
   b. Chemical weathering is a result of acids.
   c. Process of plant succession builds soil.
3. Plant growth requires certain chemical elements.
   a. Elements necessary in large quantities are nitrogen, potassium, calcium, and phosphorus.
   b. Some elements needed in only small amounts are called trace elements (boron, magnesium, etc.).
   c. Plant growth may progress in water solution independent of soil (soilless gardening).
4. Rainfall and soil fertility are directly related.
5. Soil pH needs to be determined accurately.
   a. Laboratory titration is one method.
   b. The potentiometer can be used to determine pH.
   c. Commercial soil-testing kits are simplest and quickest to use.
6. Vegetative type is dependent on soil pH.
7. The nitrogen cycle is probably the single most important chemical principle in soils.
8. Rate of oxidation of organic matter is a function of temperature.
9. Theory of colloids very important in soil study.
   a. Size of particles in soils determines absorption rate and water-holding capacity of soils.
   b. Loss of structure of clay soils results in loss of absorptive power and causes swelling and shrinkage.
10. Organic acids affect the solubility of soil minerals.

B. Soil Conservation

1. Soil depletion leads to land disaster.
   a. Loss of fertility through overcropping.
   b. Organic content is lost.
   c. Topsoil erosion causes reduction of productive capacity.
   d. Soil pH is changed as a result of poor conservation.
   e. Soil structure is lost through chemical imbalance.
2. Chemistry can aid in soil restoration.
   a. Commercial fertilizers can be supplied which contain most essential minerals.
   b. Organic content can be restored with manures and green manures.
   c. Erosion control measures are cover crops, contour farming, etc.

d. Liming counteracts acid soil.
e. Krilium is the latest synthetic which restores soil structure.
f. Permanent grass or forest cover rebuilds soil fertility.

3. Irrigation farming
a. Excess water causes loss of minerals by leaching.
b. Improper irrigation may cause soil erosion.
c. Good irrigation practices can rebuild soil.

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Puri, A. N., Soils: Their Physics and Chemistry. New York: Reinhold Publishing Corporation, 1949. pp. 1-3.

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Renner, George T. and William H. Hartley, Conservation and Citizenship. Boston: D. C. Heath and Company, 1940.

Saunderson, Mont H., Western Land and Water Use. Norman, Oklahoma: University of Oklahoma Press, 1950.

Van Hise and Loomis Havemeyer, Conservation of Our Natural Resources. New York: The Macmillan Company, 1938. pp. 319-389.

III. Chemistry and Water Conservation

A. The importance of water in life processes
   1. The human body is 70 per cent water.
   2. Water is the universal solvent, carrying nutrients to all parts of plants and animals.
   3. Plants regulate the distribution of water by permitting seepage into the ground.
   4. Moving water has tremendous earth-moving power.

B. The source problem
   1. Available moisture for growing things depends upon the precipitation-evaporation ratio.
   2. Poor forest and soil conservation lowers the amount of available water by allowing run-off.
      a. Level of ground-water table is lowered.
      b. Flooding results in silting and further erosion.
   3. Lack of water available for irrigation purposes prevents reclamation of arid land.

C. Suggested answers to the source problem
   1. Range, forest, and farm conservation practices, all coordinated toward water conservation.
   2. In some cases, large or small dams are justified.
   3. Watershed control is the most comprehensive solution.

D. The pollution problem
   1. Industrial pollution is not a great problem in Montana.
      a. Smelter wastes and pulp mill wastes are the most common forms of pollution in Montana.
      b. Stream pollution jeopardizes the health and recreation potential of a locality.
      c. Clark Fork River of Montana is rendered toxic to fish due to smelter wastes.
   2. Municipal pollution of streams is a common problem in Montana.
      a. Raw sewage is quite often dumped into streams.
      b. Treated sewage has little harmful effect upon aquatic or human life.

E. Solutions to the pollution problem
   1. Watershed control plans would include answers to all forms of pollution.
      a. Dumping of industrial waste would be regulated.
      b. All waste would be rendered harmless to plant and animal life.
      c. Through chemistry, many types of wastes could be utilized commercially.
   2. With an increasing population, the municipal sewage problem demands attention.
      a. Chemical treatment of sewage should be made mandatory.

b. Municipal sewage may, in the near future, be necessary as a source of fertilizer.

c. Milwaukee, Wisconsin, realizes a profit on conversion of sewage into fertilizer.

References for "Chemistry and Water Conservation"

Ayers, Quincy Claude, Soil Erosion and Its Control. New York: McGraw-Hill Book Company, Incorporated, 1936. pp. 83-89.

Butler, Ovid, editor and compiler, American Conservation in Picture and in Story. Washington, D. C., The American Forestry Association, 1935. pp. 120-211.

Gabrielson, Ira N., Wildlife Management. New York: The Macmillan Company, 1951. pp. 209-211.

Gustafson, A. F., C. H. Guise, et. al., Conservation in the United States. Ithaca, New York: Comstock Publishing Company, Incorporated, 1945. pp. 52-74.

Jaffe, Bernard, New World of Chemistry. New York: Silver Burdett Company, 1947. pp. 71-72, 223-224.

Kellogg, Charles E., The Soils That Support Us. New York: The Macmillan Company, 1947. pp. 74-89.

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Renner, George T. and William H. Hartley, Conservation and Citizenship. Boston: D. C. Heath and Company, 1940. pp. 141-164.

Saunderson, Mont H., Western Land and Water Use. Norman, Oklahoma: The University of Oklahoma Press, 1950.

Van Hise and Loomis Havemeyer, Conservation of Our Natural Resources. New York: The Macmillan Company, 1930. pp. 115-223.

IV. Chemistry and Wildlife Management

A. Fish Management

1. Mineral content of water determines amount and kind of available food for fish.
2. Concentration of dissolved gases determines the type of aquatic life.
   a. Dissolved oxygen favors game fish.
   b. Carbon dioxide tension favors rough fish.
3. Water pollution kills fish.
   a. Oxidation of organic pollution lowers oxygen content and increases carbon dioxide tension.
   b. Oiled water destroys some fish eggs.
   c. Some industrial pollution is toxic to fish.
   d. Rise in temperature of water in some cases causes game fish to migrate.
4. Silting from land erosion kills fish.
   a. Suspended mud particles and colloidal mud kill fish spawn by clogging gills.
   b. Decrease of light due to mud in water reduces available food for fish.
5. DDT and other poisonous sprays poison fish.

B. Conservation of Birds

1. Water birds depend upon a clean source of water rich in minerals.
   a. Oily water kills water birds by destroying waterproofing of feathers.
   b. Food supply of water birds killed by pollution and silting.
2. Bird population balance depends upon wise use of land.
   a. Soil erosion results in mineral deficiencies.
   b. Insect population favored by loss of birds.

C. Conservation of mammals

1. Grazing animals adversely affected by soil depletion.
   a. Plant life on eroded land is not nutritionally sufficient.
   b. Paralysis sometimes induced by deficiency of trace minerals.
2. Pollution of water supply may drive out animals.
3. Deer and other land animals require salt.
4. Forest fires drive out all wildlife.
   a. Chemical balance of nature is upset.
   b. Increased oxidation of organic matter destroys food.
5. Lack of forest cover forces wildlife into new areas.

References for "Chemistry and Wildlife Management"

Butler, Ovid, editor and compiler, American Conservation in Picture and in Story. Washington, D. C. : The American Forestry Association, 1935. pp. 82-93.

Gabrielson, Ira N., Wildlife Management. New York: The Macmillan Company, 1951.

Gustafson, A. F., C. H. Guise, et. al., Conservation in the United States. Ithaca, New York: Comstock Publishing Company, Incorporated, 1945. pp. 291-375.

Renner, George T., Conservation of National Resources. New York: John Wiley and Sons, Incorporated, 1942. pp. 128-135.

Renner, George T. and William H. Hartley, Conservation and Citizenship. Boston: D. C. Heath and Company, 1940 pp. 185-215.

Van Hise and Loomis Havemeyer, Conservation of Our Natural Resources. New York: The Macmillan Company, 1930. pp. 393-505.

V. Chemistry and Mineral Conservation

A. Conservation of fuels

1. United States has abundant fuel resources in the form of petroleum and coal.
2. Coal and petroleum resources could be stretched over a much longer period of time.
   a. General use of coal and gasoline is between 5 percent and 10 percent efficient.
   b. Increasing efficiency of machines would extend oil and coal reserves.
   c. Methods of utilizing low-grade coal such as lignite would supplement fuel supply.
   d. Fuel can be produced from oil shale.
   e. Natural gas now burned as waste should be utilized, if feasible.
3. Mining of coal and petroleum could be made more efficient.
   a. Some methods of coal mining are wasteful and damage and deface the land.
   b. Oil must be pumped under strict regulation to insure maximum recovery.
4. Atomic energy will have a great effect on our fuel supply.
   a. Atomic energy can be used to generate steam for industrial purposes.
   b. Central city heating is a possibility by use of atomic energy.
   c. Many power requirements will still be dependent upon other fuels.
5. The by-products of coal and petroleum refining will receive increasing attention and development.

B. Conservation of inorganic minerals

1. Abundance of inorganic minerals in the United States is much less than that of petroleum and coal.
   a. U. S. has enough copper, iron ore, phosphates, and sulfur.
   b. Magnesite, potash, vanadium, and zinc are less abundant.
   c. U. S. is partly dependent on outside sources for antimony, bauxite, chrome, graphite, mercury, and tungsten.
   d. We are completely dependent on outside sources for asbestos, industrial diamonds, manganese, mica, nickel, natural nitrates, platinum, quartz, and tin.
2. America's economic future lies in assuring herself of a continued supply of minerals.
   a. Strategic and critical minerals may be stockpiled.
   b. Friendly sources of supply must be obtained.
   c. Low-grade ores inside the country may be worked by new chemical processes.

d. Synthetics may relieve the pressure for some construction materials.

3. Synthetics provide only part of the answer to the shortage of structural materials.
   a. Most synthetics are organic in origin.
   b. The supply of organic substances is limited to what can be grown on the land.

4. Mining and refining operations present a conservation problem.
   a. Gashes in the earth and slag and refuse piles deface the land.
   b. Acid subsoils brought to the surface often make the land unsuitable for farming.
   c. Streams are rendered toxic and unfit for aquatic life.
   d. Air pollution around smelters causes death of vegetation.

References for "Chemistry and Mineral Conservation"

Fitzhugh, Edward F., Jr., Treasures in the Earth. Caldwell, Idaho: The Caxton Printers, Limited, 1937.

Gustafson, A. F., C. H. Guise, et. al., Conservation in the United States. Ithaca, New York: Comstock Publishing Company, Incorporated, 1945. pp. 379-458.

Hotchkiss, William O., Minerals of Might. Lancaster, Pennsylvania: The Jacques Cattell Press, 1945.

Jaffe, Bernard, New World of Chemistry. New York: Silver Burdett Company, 1947. p. 384.

Renner, George T., Conservation of National Resources. New York: John Wiley and Sons, Incorporated, 1942. pp. 101-111.

Renner, George T. and William H. Hartley, Conservation and Citizenship. Boston: D. C. Heath and Company, 1940. pp. 217-242.

Tarr, W. A., Introductory Economic Geology. New York: McGraw-Hill Book Company, Incorporated, 1938. pp. 14-80.

Van Hise and Loomis Havemeyer, Conservation of Our Natural Resources. New York: The Macmillan Company. 1938. pp. 17-112.

APPENDIX B

SELECTED LIST OF TEACHING MATERIALS FOR INTEGRATING CONSERVATION WITH CHEMISTRY

I. BOOKS

Gabrielson, Ira N., Wildlife Management. New York: The Macmillan Company, 1951. 247 pp.

Gustafson, A. F., C. H. Guise, et. al., Conservation in the United States. Ithaca, New York: Comstock Publishing Company, Incorporated, 1945. 477 pp.

Hotchkiss, William O., Minerals of Light. Lancaster, Pennsylvania: The Jacques Cattell Press, 1945. 206 pp.

Kellogg, Charles E., The Soils That Support Us. New York: The Macmillan Company, 1947. 370 pp.

Renner, George T., Conservation of National Resources. New York: John Wiley and Sons, Incorporated, 1942. 223 pp.

Renner, George T. and William H. Hartley, Conservation and Citizenship. Boston: D. C. Heath and Company, 1940. 367 pp.

Van Hise and Loomis Havemeyer, Conservation of Our Natural Resources. New York: The Macmillan Company, 1930. 551 pp.

II. AUDIO-VISUAL MATERIAL

16 mm. films available on loan for educational purposes from the Division of Information and Education, Forest Service, Federal Building, Missoula, Montana:

"Adventures of Junior Raindrop" -- color, sound, 7 minutes.

"Yours Is the Land" -- color, sound, 20 minutes.

Films available on loan from Minneapolis-Moline Company, Advertising Department, Minneapolis 1, Minnesota:

"The Good Earth for a Better Life" -- color, sound, 44 minutes.

"The Soil Is Good" -- color, sound, 40 minutes.

Films available on loan from the National Fertilizer Association, 616 Investment Building, Washington 5, D. C.

"Deeper Acres" -- color, sound, 11 minutes.

"The Life of the Soil" -- color, sound, Northern and Southern editions, 33 minutes.

"What's in the Bag" -- color, sound, 18 minutes.

"Hunger Signs" -- color, sound, 15 minutes.

III. MAGAZINES AND PERIODICALS

Conservation News, National Wildlife Federation, Washington, D. C.

The Land and Land News, National Headquarters, 1368 North High Street, Columbus 1, Ohio.

IV. FREE MATERIALS (BULLETINS AND PAMPHLETS)

A. Soils

Grasses and Legumes for Soil Conservation in the Pacific Northwest, Miscellaneous Publication No. 678, United States Department of Agriculture.

Wildlife Gains Through Soil Conservation, Dr. High H. Bennett, Soil Conservation Service, U. S. Department of Agriculture.

From the Dust of the Earth, Agriculture Information Bulletin No. 73, Soil Conservation Service, U. S. Department of Agriculture.

Go to Grass, Reg Manning, PA-103, Forest Service, U. S. Department of Agriculture.

Our Remaining Land, A. I. S. No. 72, Soil Conservation Service, U. S. Department of Agriculture.

Our Land and Its Care, American Plant Food Council, Incorporated, 910 Seventeenth Street, N. W., Washington 6, D. C.

Montana Soil Conservation Districts, Montan State Soil Conservation Committee, Bozeman, Montana.

Conquest of the Land Through Seven Thousand Years, S. C. S. MP-32, Soil Conservation Service, U. S. Department of Agriculture.

The Tree and the Soil, Forest Service and Soil Conservation Service, U. S. Department of Agriculture.

Youth Can Help Conserve These Resources: Soil, Water, Woodland, Wildlife, Grass, Agriculture Information Bulletin No. 52, Soil Conservation Service, U. S. Department of Agriculture.

An Outline for Teaching Conservation in High Schools, Soil Conservation Service, Education Section, U. S. Department of Agriculture.

Soil Conservation Activities for Schools, U. S. Department of Agriculture, Soil Conservation Service, Region 5, Lincoln 1, Nebraska.

The Eleventh Commandment, Walter C. Lowdermilk, Soil Conservation Service, U. S. Department of Agriculture.

The Road to Restoration, Melvin O. Steen, Soil Conservation Service, U. S. Department of Agriculture, Northern Great Plains Region, Lincoln, Nebraska.

Teamwork to Save Soil and Increase Production, Miscellaneous Publication No. 486, Soil Conservation Service, U. S. Department of Agriculture.

Our American Land, The Story of Its Abuse and Its Conservation, Miscellaneous Publication No. 596, Soil Conservation Service, U. S. Department of Agriculture.

Books, Booklets, Bulletins on Soil and Water Conservation, Agriculture Information Bulletin No. 63, Soil Conservation Service, U. S. Department of Agriculture.

Resource Agencies for Education in Soil and Water Conservation, Conservation Workshop, University of Montana, Missoula.

B. Water

Water and Our Forests, Agriculture Information Bulletin No. 71, Forest Service, U. S. Department of Agriculture.

Know Your Watersheds, Leaflet No. 282, Forest Service, U. S. Department of Agriculture.

Books, Booklets, Bulletins on Soil and Water Conservation, Agriculture Information Bulletin No. 63, Soil Conservation Service, U. S. Department of Agriculture.

Water Producing a Crop, Soil Conservation Service, U. S. Department of Agriculture, Region 5, Lincoln, Nebraska.

C. Forest

Managing the Small Forest, Farmers' Bulletin No. 1989, U. S. Department of Agriculture.

Making Paper from Trees, Forest Service, U. S. Department of Agriculture.

Why the Leaves Change Their Color, K-26, Forest Service, U. S. Department of Agriculture.

How Our Forests Serve Us, O-24, Forest Service, U. S. Department of Agriculture.

Wood, The Material of a Thousand Uses, Forest Service, U. S. Department of Agriculture.

Enemies of the Forests, O-25, Forest Service, U. S. Department of Agriculture.

Forests and Wildlife, O-27, Forest Service, U. S. Department of Agriculture.

Edible Fruits of Forest Trees, K-6, Forest Service, U. S. Department of Agriculture.

Suggestions for Integrating Forestry in the Modern Curriculum, Forest Service, U. S. Department of Agriculture.

Water and Our Forests, Agriculture Information Bulletin No. 71, Forest Service, U. S. Department of Agriculture.

Questions and Answers about Grazing on National Forests, A I S No. 50, Forest Service, U. S. Department of Agriculture.

What Are We Aiming At?, AIS No. 10, Forest Service, U. S. Department of Agriculture.

Materials to Help Teach Forest Conservation, K-28, Forest Service, U. S. Department of Agriculture.

What We Get From Trees, Forest Service, U. S. Department of Agriculture.

Forests for the Future, O-26, Forest Service, U. S. Department of Agriculture.

The Tree and the Soil, Forest Service, U. S. Department of Agriculture.

You and Forest Fires, PA-64, Forest Service, U. S. Department of Agriculture.

Forest Fire-Thunderstorm: Knockout Combination for Watersheds, C. Allan Friedrich, Research Note No. 102, Northern Rocky Mountain Forest and Range Experiment Station, Missoula, Montana.

Complete list of publications available may be obtained from U. S. Forest Service, Division of Information and Education, Missoula, Montana.

D. Wildlife

Wildlife Gains Through Soil Conservation, Hugh H. Bennett, U. S. D. A. Soil Conservation Service, Washington, D. C.

Forests and Wildlife, No. O-27, Forest Service, U. S. Department of Agriculture.

The Relation of Pheasants to Agriculture in Montana, Montana Fish and Game Commission, Wildlife Restoration Division.

The Road to Restoration, Melvin O. Steen, U. S. Department of Agriculture, Soil Conservation Service, Northern Great Plains Region, Lincoln, Nebraska.

Water Producing a Crop, U. S. Department of Agriculture, Soil Conservation Service, Northern Great Plains Region, Lincoln, Nebraska.